

CONTRIBUTIONS  
FROM THE  
CUSHMAN LABORATORY  
FOR  
FORAMINIFERAL RESEARCH

---

VOLUME 16, PART 4

DECEMBER, 1940

---

CONTENTS

	PAGE
No. 223. American Upper Cretaceous Foraminifera of the Genera <i>Dentalina</i> and <i>Nodosaria</i> .....	75
Recent Literature on the Foraminifera.....	96

SHARON, MASSACHUSETTS, U. S. A.

1940

# CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

Brook Road, Sharon, Mass., U. S. A.

JOSEPH A. CUSHMAN, SC.D., *Director*

ALICE E. CUSHMAN, *Secretary, in charge of Publications*

RUTH TODD, M. S., *Secretary and Research Assistant*

ANN SHEPARD GREEN, *Illustrator*

These Contributions will be issued quarterly. They will contain short papers with plates, describing new forms and other interesting notes on the general research work on the foraminifera being done on the group by the workers in this laboratory. New literature as it comes to hand will be briefly reviewed.

Subscription \$2.50 per year post paid.

Volume 1, April 1925—January 1926 (Reprinted, 1935) .....	\$3.00
Volume 2, April 1926—January 1927 (Reprinted, 1935) .....	\$3.00
(Volume 3, part 1 now out of print.)	
Volume 3, parts 2-4, June—December, 1927 (Reprinted, 1936) .....	\$2.00
Volume 4, parts 1-4, March—December, 1928, complete .....	\$2.50
Volume 5, parts 1-4, March—December, 1929, complete .....	\$2.50
Index to Volumes 1—5 inclusive .....	\$1.00
Volume 6, parts 1-4, March—December, 1930, complete .....	\$2.50
Volume 7, parts 1-4, March—December, 1931, complete .....	\$2.50
Volume 8, parts 1-4, March—December, 1932, complete .....	\$2.50
Volume 9, parts 1-4, March—December, 1933, complete .....	\$2.50
Volume 10, parts 1-4, March—December, 1934, complete .....	\$2.50
Index to Volumes 6—10 inclusive .....	\$1.00
Volume 11, parts 1-4, March—December, 1935, complete .....	\$2.50
Volume 12, parts 1-4, March—December, 1936, complete .....	\$2.50
Volume 13, parts 1-4, March—December, 1937, complete .....	\$2.50
Volume 14, parts 1-4, March—December, 1938, complete .....	\$2.50
Volume 15, parts 1-4, March—December, 1939, complete .....	\$2.50
Index to Volumes 11—15 inclusive .....	\$1.00
Volume 16, parts 1-4, March—December, 1940, complete .....	\$2.50
Volume 17 subscription, 1941 .....	\$2.50

## Special Publications:

- No. 1. Foraminifera, Their Classification and Economic Use. 1928.. \$5.00
  - No. 2. A Resumé of New Genera of the Foraminifera Erected Since  
Early 1928. 1930..... .50
  - No. 3. A Bibliography of American Foraminifera. 1932..... 1.10
  - (No. 4: Foraminifera, Their Classification and Economic Use,  
Edition 2. 1933. Out of Print.)
  - No. 5. An Illustrated Key to the Genera of the Foraminifera. 1933.  
\$1.00; foreign \$1.50
  - No. 6. New Genera and Species of the Families Verneuilinidae and  
Valvulinidae and of the Subfamily Virgulininae. 1936.. 1.50
- For continuation of this series, see back cover page.

Copies of Volume 16, part 4 were first mailed December 7, 1940

PRESS OF M. A. JOHNSTON, BRIDGEWATER, MASSACHUSETTS, U. S. A.



# CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

## 223. AMERICAN UPPER CRETACEOUS FORAMINIFERA OF THE GENERA DENTALINA AND NODOSARIA\*

By JOSEPH A. CUSHMAN

The species in our American Cretaceous belonging to the genera *Dentalina* and *Nodosaria* have been much confused. Some of them have long vertical ranges, but others have relatively short ranges and have proved to be good index fossils for stratigraphic use. A study of types in various European museums together with much available topotype material has helped to refine specific identifications of many of our species. Some of the holotypes have been redrawn on our plates. Thanks are due to the Director of the U. S. Geological Survey for the use of the figures pending publication of a large paper on the Foraminifera of the American Upper Cretaceous.

### Family LAGENIDAE

Genus DENTALINA d'Orbigny, 1826

DENTALINA INVOLVENS Cushman (Pl. 13, fig. 1)

*Dentalina involvens* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 37, pl. 6, fig. 3.

Test small, elongate, slender, of nearly uniform diameter throughout, slightly curved, initial end with a distinct spine; chambers few, distinct, except the earliest ones, later ones slightly inflated, somewhat overlapping; early sutures indistinct, later ones slightly depressed; wall ornamented by longitudinal costae, those of the early portion coarse and strongly twisted,

\* Published by permission of the Director of the United States Geological Survey.

later ones more numerous, finer and less oblique, independent of the sutures; aperture radiate, terminal, slightly excentric. Length up to 1.00 mm.; diameter 0.15 mm.

The types are from Austin chalk, on road at N. edge of Whitewright, north-facing slope of branch valley, Grayson County, Texas.

This is a peculiarly ornamented species, and holds its characters very closely. It differs from *D. alternata* (Jones) in the smaller, more slender test, fewer costae, and the peculiarly twisted character of the ornamentation.

*DENTALINA ALTERNATA* (Jones) (Pl. 13, figs. 2-6)

*Nodosaria zippei* REUSS, var. *alternata* JONES, in WRIGHT, Proc. Belfast Nat. Field Club, 1884-85. Appendix 9, 1886, p. 330, pl. 27, fig. 10.

*Dentalina alternata* PLUMMER, Univ. Texas Bull. 3101, 1931, p. 153, pl. XI, fig. 7.—SANDIDGE, Journ. Pal., vol. 6, 1932, p. 274, pl. 42, fig. 6.

*Nodosaria alternata* CARSEY, Univ. Texas Bull. 2612, 1926 (1927), p. 35, pl. 4, fig. 7.

*Nodosaria intercostata* CUSHMAN (not REUSS), Tenn. Div. Geol., Bull. 41, 1931, p. 31, pl. 4, figs. 1, 2.

*Nodosaria affinis* CUSHMAN (part) (not REUSS), Journ. Pal., vol. 5, 1931, p. 305, pl. 33, fig. 2 (not 3-5).

*Dentalina pinnigera* SANDIDGE, l. c., vol. 6, 1932, p. 274, pl. 42, figs. 11, 12.

Test elongate, very slightly tapering, initial end with a single, stout spine; chambers of fairly uniform size, increasing slightly in length and diameter as added; sutures distinct, slightly depressed; wall ornamented by a few distinct, longitudinal, plate-like costae continuous over adjacent chambers and between these, secondary costae, usually broken at the sutures; aperture radiate, terminal. Length up to 1.50 mm.; diameter 0.25 mm.

This is a rather distinctive species with its peculiar arrangement of the costae. The last-formed chambers may become globular and somewhat set off from each other by much contracted necks. Specimens are easily broken and these final chambers are usually missing. The species ranges from the upper part of the Austin chalk through the Taylor and into the Neylandville marl of the lower Navarro.

I have examined topotype material of both *N. intercostata* Reuss and Jones' species, and our material is identical with that of Jones from the chalk of Ireland. There is some question as to whether this species should be placed under *Dentalina* or *Nodosaria*.



## DENTALINA LEGUMEN Reuss (Pl. 13, figs. 7, 8)

*Dentalina legumen* REUSS, Haidinger's Nat. Abhandl., vol. 4, 1851, p. 10, pl. 1, fig. 14; Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 187, pl. 3, fig. 5.—FRANKE, Abhandl. Preuss. geol. Landes., vol. 111, 1928, p. 27, pl. 2, fig. 23.—CUSHMAN, Tenn. Div. Geol. Bull. 41, 1931, p. 27, pl. 3, fig. 1.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 30, pl. 9, fig. 9.—BROTZEN, Sver. geol. under., ser. C, No. 396, 1936, p. 75, pl. 5, fig. 9.

*Dentalina nana* CUSHMAN (not REUSS), Tenn. Div. Geol., Bull. 41, 1931, p. 29, pl. 3, fig. 21.

This is a very variable species, originally described by Reuss from the Cretaceous of Lemberg. An examination of material from Lemberg shows that this species is variable in the obliquity of the sutures and in the amount of inflation of the chambers. The type figures of *D. legumen* Reuss and *D. nana* Reuss appear quite different but when larger series of specimens are studied, the American specimens at least seem to be variable enough to include both forms in one series. Figures of several specimens are given to show this variation.

Forms included under this name have a wide range in our Cretaceous including the Navarro, Taylor, and Austin.

## DENTALINA GRACILIS d'Orbigny (Pl. 13, figs. 9-11)

*Dentalina gracilis* D'ORBIGNY, Mém. Soc. géol. France, ser. 1, vol. 4, 1840, p. 14, pl. 1, fig. 5.—FRANKE, Abhandl. Preuss. geol. Landes., vol. 111, 1928, p. 29, pl. 2, fig. 22.

Under this name d'Orbigny figures a slender, somewhat curved species which corresponds well with some of our American forms. From a study of our material it is very variable, and some of these variations are to be found on our plate. The range of such forms is wide, and later studies may show that they include more than one species.

## DENTALINA LORNEIANA d'Orbigny (Pl. 13, figs. 12-14)

*Dentalina lorneiana* D'ORBIGNY, Mém. Soc. géol. France, ser. 1, vol. 4, 1840, p. 14, pl. 1, figs. 8, 9.—FRANKE, Abhandl. Preuss. geol. Landes., vol. 111, 1928, p. 28, pl. 2, fig. 29.—CUSHMAN, Tenn. Div. Geol., Bull. 41, 1931, p. 28, pl. 3, figs. 4-7.

*Nodosaria lorneiana* REUSS, Verst. böhm. Kreide., pt. 1, 1845, p. 27, pl. 8, fig. 5.—FRANKE, Abhandl. Greifswald Univ., Geol.-pal. Inst., vol. 6, 1925, p. 34, pl. 3, fig. 12.

Test elongate, slender, slightly curved, initial end usually broadly rounded; chambers increasing rapidly in length as added, diameter increasing very slowly, slightly inflated; sutures distinct, slightly depressed; wall smooth; aperture terminal, radiate. Length up to 2.00 mm.; diameter 0.15-0.18 mm.

The types of this species are from the Upper Cretaceous of the Paris Basin. It is widely distributed in Europe and America. It has been recorded from America also as *D. legumen* Reuss, but is not the same. The range is evidently wide as specimens referable to it occur in the Brownstown marl and Gober tongue of the Austin, in both upper and lower portions of the Taylor, and in the lower part of the Navarro group.

*DENTALINA LORNEIANA* d'Orbigny, var. *SPIRANS* Cushman (Pl. 13, fig. 15)

*Dentalina lorneiana* D'ORBIGNY, var. *spirans* CUSHMAN, Tenn. Div. Geol., Bull. 41, 1931, p. 28, pl. 3, fig. 2.

Variety differing from the typical in the ornamentation of the surface which consists of elongate spiral costae, generally continuous over the adjacent chambers.

The types of the variety are from the Ripley formation of Navarro age, New Corinth Highway, 13½ miles S. of Selmer, McNairy Co., Tenn.

#### EXPLANATION OF PLATE 13

*a*, front view; *b*, apertural view.

FIG. 1. *Dentalina involvens* Cushman. × 38. Holotype. Austin chalk, Grayson Co., Tex. 2-6. *D. alternata* (Jones). 2, × 25. Saratoga chalk, Howard Co., Ark. 3, 4, × 38. Upper Taylor marl, Kaufman Co., Tex. 5, 6, × 38. Ripley formation, Henderson Co., Tenn. 7, 8. *D. legumen* Reuss. 7, × 35. Ripley formation, Henderson Co., Tenn. 8, × 42. (After Cushman and Jarvis.) Cretaceous, Trinidad. 9-11. *D. gracilis* d'Orbigny. × 60. 9, Prairie Bluff chalk, Chickasaw Co., Miss. 10, Brownstown marl, Red River Co., Tex. 11, Austin chalk, Grayson Co., Tex. 12-14. *D. lorneiana* d'Orbigny. × 90. Ripley formation, Henderson Co., Tenn. 13, McNairy Co., Tenn. 15. *D. lorneiana* d'Orbigny, var. *spirans* Cushman. × 90. Holotype. Ripley formation, McNairy Co., Tenn. 16, 17. *D. reflexa* Morrow. × 58. Niobrara chalk, Ellis Co., Kans. Redrawn from original types. 18-20. *D. fallax* Franke. × 38. Upper Taylor marl, Williamson Co., Tex. 21, 22. *D. basitorta* Cushman. × 38. Selma chalk (upper part), Union Co., Miss. 23-25. *D. multicostata* d'Orbigny. × 38. Upper Taylor marl. 23, 24, Delta Co., Tex. 25, Lamar Co., Tex. 26-28. *D. megalopolitana* Reuss. 26, × 38. Selma chalk (middle part), Hardin Co., Tenn. 27, × 42. Saratoga chalk, Howard Co., Ark. 28, × 20. (After Cushman and Jarvis.) Cretaceous, Trinidad. 29-34. *D. catenula* Reuss. × 38. Pecan Gap chalk, Falls Co., Tex.









**DENTALINA REFLEXA** Morrow (Pl. 13, figs. 16, 17)

*Dentalina reflexa* MORROW, Journ. Pal., vol. 8, 1934, p. 189, pl. 29, figs. 5, 20.

"Test elongate, slightly arcuate; successive chambers not increasing appreciably in length and but very little in diameter; initial end pointed, curving slightly reverse to the main curvature of the test; chambers few, distinct, depressed, oblique, especially in early chambers; wall smooth. Length of holotype, 0.9 mm.; thickness 0.16 mm."

The types are from the basal Niobrara, sec. 32, T. 11 S., R. 16 W., Ellis Co., Kans. The types are redrawn on our plate, but are not very well preserved as to details, and the species must be left until more material is available.

**DENTALINA FALLAX** Franke (Pl. 13, figs. 18-20)

*Dentalina fallax* FRANKE, Abhandl. Preuss. geol. Landes., vol. 111, 1928, p. 27, pl. 2, fig. 18.

Test elongate, very slightly tapering, initial end with a distinct spine; chambers distinct, proloculum usually larger than the next succeeding chambers which are not inflated but followed by chambers becoming more inflated toward the apertural end, strongly overlapping; sutures distinct, earlier ones not depressed but later ones progressively more so; wall smooth; aperture terminal, radiate, with a slender neck. Length 0.70-0.85 mm.; diameter 0.18-0.20 mm.

The types are from the Upper Cretaceous of Germany. At a single locality in the upper part of the Taylor marl this species is fairly common, but was not seen elsewhere. The European occurrence compares closely to the American one stratigraphically, and

## EXPLANATION OF PLATE 14

FIGS. 1-6. *Dentalina basiplanata* Cushman.  $\times 38$ . Corsicana marl, Navarro Co., Tex. 1, Holotype. 2-6, Paratypes. 7, 8. *D. angusticostata* Cushman.  $\times 60$ . Corsicana marl, Limestone Co., Tex. 7, Holotype. 8, Paratype. 9-12. *D. confluens* Reuss. 9,  $\times 42$ . Saratoga chalk, Howard Co., Ark. 10-12,  $\times 20$ . (After Cushman and Jarvis.) Upper Cretaceous, Trinidad. 13-17. *D. solvata* Cushman.  $\times 38$ . Selma chalk (upper part), Prentiss Co., Miss. 18-21. *D. pertinens* Cushman.  $\times 38$ . Upper Taylor marl, Navarro Co., Tex. 22-26. *D. cf. consobrina* d'Orbigny. 22-24,  $\times 75$ . Ripley formation, McNairy Co., Tenn. 25, 26,  $\times 27$ . (After Cushman and Jarvis.) Cretaceous, Trinidad. 27. *D. annulata* (Reuss).  $\times 60$ . (After Cushman and Jarvis.) Cretaceous, Trinidad. 28, 29. *D. crinita* Plummer.  $\times 38$ . Corsicana marl, Limestone Co., Tex.

the species is to be looked for at other American localities in the upper part of the Taylor.

**DENTALINA BASITORTA** Cushman (Pl. 13, figs. 21, 22)

*Dentalina basitorta* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 37, pl. 6, figs. 4, 5.

Test elongate, slender, somewhat curved, initial end with a basal spine, early portion with the chambers somewhat twisted, later uniserial; chambers distinct, the earliest ones elongate, twisted about the elongate axis or even appearing somewhat irregularly biserial, not inflated, later ones strongly inflated, less overlapping; sutures distinct, earlier ones very strongly oblique, not depressed, later ones gradually less oblique and progressively more depressed; wall smooth; aperture terminal, radiate. Length up to 1.00 mm.; diameter 0.18 mm.

The types are from near the top of the Selma chalk, Alpina road, 2 miles S. of Graham, Union Co., Miss. It also occurs at several localities in the Taylor marl. *Dentalina basitorta* differs from *D. legumen* Reuss in the early stages which in our species are very peculiarly twisted and the sutures very oblique. This peculiar early character is held in all the specimens to a greater or lesser degree, and should make this species easily recognizable and perhaps a good index fossil for the Taylor marl.

**DENTALINA MULTICOSTATA** d'Orbigny (Pl. 13, figs. 23-25)

*Dentalina multicostata* D'ORBIGNY, Mém. Soc. géol. France, ser 1, vol. 4, 1840, p. 15, pl. 1, figs. 14, 15.

There are specimens from the upper part of the Taylor marl of Texas that seem to be identical with the species described by d'Orbigny from the Upper Cretaceous chalk of the Paris Basin. The stratigraphic position in the two areas is consistent. Although none of our specimens is complete, enough is present to show that the species is gently tapering, with globular chambers rather closely set, and the wall ornamented by numerous, distinct, longitudinal costae which may be somewhat oblique. From what is known of its occurrence, this should be a good index fossil for the Taylor marl.

**DENTALINA MEGALOPOLITANA** Reuss (Pl. 13, figs. 26-28)

*Dentalina megalopolitana* REUSS, Zeitschr. Deutsche geol. Ges., vol. 7, 1855, p. 267, pl. 8, fig. 10.—CUSHMAN, Journ. Pal., vol. 5, 1931, p. 304,



pl. 34, fig. 17; Tenn. Div. Geol., Bull. 41, 1931, p. 29, pl. 3, fig. 8; Journ. Pal., vol. 6, 1932, p. 335.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 29, pl. 9, fig. 5.

Test large, fairly stout, tapering, slightly fusiform, greatest breadth developed before the last-formed chamber in the adult; chambers numerous, not inflated, distinct, of uniform shape, gradually increasing in size as added, the later ones often slightly decreasing; sutures distinct, not depressed, slightly oblique; wall smooth; aperture radiate, slightly protuberant at the inner angle of the terminal face of the last-formed chamber. Length up to 2.00 mm.; breadth up to 0.30 mm.

Our American specimens agree well with those of the European Cretaceous. Most of the American records are from the upper part of the Taylor marl or its equivalents. Specimens referred to this from the Cretaceous of Trinidad are not so typical as those from the Taylor.

**DENTALINA CATENULA** Reuss (Pl. 13, figs. 29-34)

*Dentalina catenula* REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 185, pl. 3, fig. 6.

Test elongate, tapering, slightly curved, initial end usually with a distinct spine; chambers pyriform, somewhat overlapping, increasing rather uniformly in size as added, of uniform shape, greatest diameter below the middle and more tapering toward the apertural end; sutures distinct, strongly depressed; wall smooth; aperture terminal, radiate. Length up to 2.00 mm.; diameter 0.35-0.45 mm.

The types of this species are from the Upper Cretaceous of Westphalia, Germany. Our American material has been compared with topotype material, and seems identical. In the Gulf Coastal Plain area the species is widely distributed, and is confined to the middle and upper portions of the Taylor marl with occasional specimens in the Neylandville marl of the lower part of the Navarro group. The species varies in the amount of overlapping of the chambers and in the early portion in the microspheric and megalospheric forms as will be seen by the figures on our plate. From a study of topotype material it seems that the species described by Reuss in 1845 as *Nodosaria oligostegia* from the Cretaceous of Bohemia differs from this, but that the material he referred to *Dentalina oligostegia* in 1851 from the Cretaceous of Lemberg is the same as *D. catenula*.

## DENTALINA BASIPLANATA Cushman (Pl. 14, figs. 1-6)

*Dentalina annulata* CUSHMAN (not REUSS), Tenn. Div. Geol., Bull. 41, 1931, p. 28, pl. 3, fig. 3.

*Dentalina basiplanata* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 38, pl. 6, figs. 6-8.

Test very elongate, slightly tapering, usually slightly curved, early portion showing oblique costae indicating coiling, especially in the microspheric form, often slightly compressed; chambers distinct, earlier ones not inflated, later becoming increasingly inflated as added, earlier ones much more strongly overlapping; sutures distinct, somewhat limbate, earlier ones flush with the surface, oblique, later ones progressively more depressed and more nearly at right angles to the elongate axis; wall smooth, or the earliest portion sometimes slightly roughened; aperture terminal, radiate. Length up to 2.50 mm.; diameter 0.20-0.25 mm.

The types are from Corsicana marl, clay pit 2 miles S. of Corsicana Court House, Navarro Co., Texas. This species is often very abundant in the Corsicana marl, Kemp clay and Arkadelphia marl. Specimens occur less commonly in the lower part of the Navarro group, and there are rare specimens from the Taylor. There are specimens in the Upper Cretaceous of Mexico that may be referred here also.

*D. basiplanata* differs from *D. annulata* Reuss in the less tapering test, more limbate sutures and the peculiarly compressed chambers of the early stages. Some of the specimens from the Selma chalk that have been referred to *D. megalopolitana* Reuss also belong here as well as those from the Saratoga chalk referred to under the same name (Cushman, Journ. Pal., vol. 5, 1931, p. 304, pl. 34, fig. 17).

## DENTALINA CONFLUENS Reuss (Pl. 14, figs. 9-12)

*Dentalina confluens* REUSS, Sitz. Akad. Wiss. Wien, vol. 44, 1861 (1862), p. 335, pl. 7, fig. 5.—FRANKE, Abhandl. Preuss. geol. Landes., vol. 111, 1928, p. 36, pl. 3, fig. 14.—CUSHMAN, Journ. Pal., vol. 5, 1931, p. 304, pl. 35, fig. 1.—SANDIDGE, l. c., vol. 6, 1932, p. 273, pl. 42, fig. 9.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 30, pl. 9, figs. 10-12.

The above references give the records for this species, originally described from Cretaceous greensands of New Jersey. As



the types are not available, various forms have been assigned to this name. Most of these are slightly tapering with longitudinal costae somewhat twisted and unbroken at the sutures. In our material they are mostly from the Navarro and the upper part of the Taylor, but they may well represent more than one species. Similar specimens occur in the Upper Cretaceous, pit at Lizard Springs, near Guayaguayare, southeastern Trinidad. Larger series of specimens are necessary to give the full details of variation.

**DENTALINA SOLVATA** Cushman (Pl. 14, figs. 13-17)

*Dentalina solvata* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 39, pl. 6, figs. 9-14.

Test elongate, slender, slightly curved, initial end with a short spine; chambers distinct, early ones slightly overlapping, gradually increasing in size as added and becoming less overlapping until in the adult they are in a loose series, somewhat longer than broad, connected by narrow, stolon-like portions; sutures distinct, strongly limbate, more and more depressed as growth proceeds; wall in the early portion with longitudinal costae, 8 to 10 in number, in the later chambers the main surface smooth, but the costae persisting over the sutures; aperture terminal, radiate. Length up to 3.00 mm.; diameter 0.20-0.22 mm.

The types are from Selma chalk, gully near public road, 3½ miles NW. of Booneville, Miss. The species occurs at a number of localities in the upper part of the Taylor marl, and in the lower part of the Navarro as well as scattered specimens elsewhere. The later chambers become much separated from each other, and the connecting stolons are easily broken so that perfect specimens are very rare.

**DENTALINA CRINITA**, Plummer (Pl. 14, figs. 28, 29)

*Dentalina crinita* PLUMMER, Univ. Texas Bull. 3101, 1931, p. 154, pl. 11, figs. 12, 13.—SANDIDGE, Journ. Pal., vol. 6, 1932, p. 274, pl. 42, fig. 5.

Test very elongate, slender, of nearly uniform diameter throughout; chambers distinct, earliest ones not inflated, much overlapping, later ones gradually more inflated and less overlapping, one side often flattened and the other convex; sutures distinct, slightly limbate, slightly if at all oblique, later ones depressed; wall in the earliest portion smooth, later with a fine ornamentation consisting mostly of irregular spinose projections

arranged more or less in longitudinal lines; aperture terminal. Length up to 3.00 mm.; diameter 0.18-0.22 mm.

The types are from the Corsicana marl, pit of Corsicana Brick Company about 2 miles S. of Corsicana, Navarro Co., Texas. The species evidently has a rather long range for one so highly ornamented. Specimens which have been placed under this specific name are from the various formations of the Navarro group, Arkadelphia marl, Kemp clay, Corsicana marl, Nacatoch sand, and Neylandville marl, from the Saratoga chalk, and a number of localities in the Taylor. The very elongate test is distinctive, but the ornamentation is subject to considerable variation from nearly smooth to a highly ornamented test.

*DENTALINA* cf. *CONSOBRINA* d'Orbigny (Pl. 14, figs. 22-26)

To this species are referred specimens, most of which are incomplete, showing the earliest chamber with usually a basal spine and succeeding chambers rapidly increasing in length as the test develops. The apertural end is not well preserved in any of our specimens. In some respects they resemble *D. lorneiana* d'Orbigny, but the chambers become much more elongate. Specimens from Tennessee have already been referred to this species (Cushman, Tenn. Div. Geol., Bull. 41, 1931, p. 30, pl. 3, figs. 13-15), and from Trinidad (Cushman and Jarvis, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 29, pl. 9, figs. 6, 7).

Specimens occur in the upper Taylor marl and Selma chalk with a few specimens from the Navarro, in the Corsicana marl and Kemp clay. Besides Trinidad, it occurs in the Velasco shale of Mexico.

*DENTALINA* *PERTINENS* Cushman (Pl. 14, figs. 18-21)

*Dentalina pertinens* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 40, pl. 6, figs. 15-18.

Test rather short, tapering, especially in the microspheric form which is pointed and very narrow in the early portion, greatest breadth toward the apertural end; chambers of the early portion indistinct and not inflated, later inflated and less overlapping; sutures distinct except in the early portion, slightly limbate, progressively more depressed toward the apertural end; wall ornamented by very fine, numerous, longitudinal costae, twisted, particularly so in the earlier portion, running from the initial end to the aperture independent of the sutures; aperture terminal, radi-



ate, excentric, slightly projecting. Length up to 1.00 mm.; diameter 0.30 mm.

The types are from the upper part of the Taylor marl, on road to Corsicana, 2.6 miles E. of Barry, Navarro Co., Texas. This species differs from *D. multicostata* d'Orbigny in the much smaller size, finer costae, and very decided twist to the ornamentation, especially in the early portion. Besides the upper part of the Taylor, it occurs in the Selma chalk of Mississippi in material of early Navarro age.

**DENTALINA DELICATULA** Cushman (Pl. 15, figs. 1-6)

*Dentalina delicatula* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 40, pl. 6, figs. 19, 20.

Test elongate, slender, gently curved, initial end with a distinct spine, very slightly tapering; chambers distinct, earlier ones not inflated, somewhat overlapping, increasing very slightly in height as added until, in the adult, becoming more remote and strongly inflated, somewhat pyriform; sutures distinct, limbate, later ones somewhat depressed; wall ornamented with numerous, 15 to 20, rather high, plate-like, longitudinal costae, somewhat less raised and more delicate on the final chambers, independent of the sutures; aperture terminal, radiate, with a tapering neck. Length up to 1.60 mm.; diameter 0.20 mm.

The types are from Corsicana marl, 35 feet above base of bluff on Onion Creek, 2½ miles W. of Old Garfield, Travis Co., Texas. In some respects this species resembles *D. alternata* (Jones), but it is a more delicate, thinner walled form, with a larger number of costae. It seems to be characteristic of the Corsicana marl.

**DENTALINA ANGUSTICOSTATA** Cushman (Pl. 14, figs. 7, 8)

*Dentalina angusticostata* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 41, pl. 6, figs. 21, 22.

Test elongate, slender, slightly curved, very gradually tapering; chambers distinct, somewhat inflated, somewhat fusiform, longer than broad, only slightly overlapping, increasing very gradually in size as added; sutures distinct, depressed, somewhat limbate; wall ornamented with very numerous longitudinal costae continuing across the sutures and to the apertural end; aperture radiate, the apertural chamberlet somewhat projecting. Length up to 3.00 mm. or more; diameter up to 0.30 mm.

The types are from Corsicana marl of the Navarro group,

Mexia highway at forks of Wortham road, 2.8 miles ESE. of Cooledge, Limestone Co., Texas. This species differs from *D. multicosata* d'Orbigny in the more slender test, more fusiform chambers, and very abundant and narrow costae.

**DENTALINA ANNULATA** (Reuss) (Pl. 14, fig. 27)

*Nodosaria annulata* REUSS, Geogn. Skizzen Böhm., vol. 2, pt. 1, 1844, p. 210; Verstein. böhm. Kreide., pt. 1, 1845, p. 27, pl. 8, figs. 4, 67; pl. 13, fig. 21; (in GEINITZ), Palaeontographica, vol. 20, 1872-75 (1874), p. 85, pl. 20, figs. 19, 20.

*Dentalina annulata* REUSS, Haidinger's Nat. Abhandl., vol. 3, pt. 2, 1850, p. 269, pl. 13, fig. 29; l. c., vol. 4, pt. 1, 1851, p. 26, pl. 1, fig. 13.—FRANKE, Abhandl. Preuss. geol. Landes., vol. 111, 1928, p. 34, pl. 2, figs. 34, 35.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 30, pl. 10, fig. 1.

*Dentalina* cf. *adolphina* CUSHMAN and JARVIS (not D'ORBIGNY), Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 97, pl. 14, fig. 6.

Test much elongate, slender, tapering, greatest width toward the apertural end; chambers distinct, inflated, subglobular, increasing rather uniformly in size, the early ones somewhat less inflated; sutures distinct, depressed, more so between the later chambers; wall smooth; aperture radiate, terminal. Length 0.80-1.25 mm.; diameter 0.15-0.25 mm.

The figure is from a specimen from the Upper Cretaceous of Trinidad. It occurs in similar form in the Velasco shale of Mexico.

**DENTALINA** sp(?) (Pl. 15, fig. 7)

*Dentalina catenula* CUSHMAN and JARVIS (not REUSS), Proc. U. S. Nat.

Mus., vol. 80, Art. 14, 1932, p. 29, pl. 9, figs. 8 a, b.

A figure is given of a peculiar dentaline form with a narrow, elongate aperture at one side of the final chamber and the base with a distinct spine. It is from the Upper Cretaceous of Trinidad. A somewhat similar form occurs in the Velasco shale of Mexico.

**Genus NODOSARIA Lamarck, 1812**

**NODOSARIA AFFINIS** Reuss (Pl. 15, figs. 8-23)

*Nodosaria affinis* REUSS, Verstein. böhm. Kreide., pt. 1, 1845, p. 26, pl. XIII, fig. 16; Palaeontographica, vol. 20, pt. 2, 1872-75 (1874), p. 83, pl. II (20), fig. 12.—PERNER, Foram. Ceskeho Cenomann, 1892, p. 57, pl. 6, figs. 10, 14 a, b.—FRANKE, Abhandl. Greifswald Univ., Geol.-pal. Inst., vol. 6, 1925, p. 37, pl. 3, fig. 25.—W. BERRY and KELLEY, Proc. U. S. Nat. Mus., vol. 76, Art. 19, 1929, p. 6, pl. 1, fig. 8.—CUSHMAN, Tenn. Div. Geol., Bull. 41, 1931, p. 30, pl. 3, figs. 16-20; Journ. Pal.,



vol. 5, 1931, p. 305, pl. 35, figs. 3-5 (not fig. 2); Contr. Cushman Lab. Foram. Res., vol. 7, 1931, p. 38, pl. 5, fig. 4.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 34, pl. 10, fig. 13.—CUSHMAN, Bull. Geol. Soc. Amer., vol. 47, 1936, p. 417.

*Nodosaria proxima* W. BERRY and KELLEY (not SILVESTRI), Proc. U. S. Nat. Mus., vol. 76, Art. 19, 1929, p. 7, pl. 1, fig. 13.

Test elongate, of variable shape in the microspheric and megalospheric forms, the former with many chambers and tapering, the greatest width near the apertural end, the latter with the chambers of nearly uniform diameter throughout; chambers distinct, inflated, especially toward the apertural end, initial end usually with a stout spine; sutures distinct, depressed, often somewhat limbate; wall ornamented by numerous (usually 13 to 15) longitudinal costae, continuous over the adjacent chambers, usually sharp and plate-like; aperture radiate, terminal, with a slight projection of the apertural face. Length up to 2.00 mm. or more; diameter normally about 0.30 mm.; but in extreme megalospheric forms may be as much as 0.75 mm.

This species was described from the Cretaceous of Bohemia. An examination of specimens named by Reuss in the collection at Dresden shows that our material is to be included in his species. Specimens show great variation from microspheric ones, with very slender early stages increasing gradually to the largest chamber at the apertural end to megalospheric forms with very large proloculum and only two or three succeeding chambers becoming rapidly much smaller. The microspheric form is often somewhat curved. The species apparently ranges throughout the Upper Cretaceous except the Eagle Ford.

*NODOSARIA DISTANS* Reuss (Pl. 15, figs. 24, 25)

*Nodosaria distans* REUSS, Zeitschr. Deutsche geol. Ges., vol. 7, 1855, p. 264, pl. 8, fig. 5.

A fragmentary specimen from the Cretaceous of Germany is figured by Reuss under this name. It represents the adult portion with chambers somewhat separated by stolon-like connections. The surface is ornamented by longitudinal costae, not interrupted at the sutures, and the chambers polygonal in transverse section. Similar specimens occurred in our material, particularly in the upper portion of the Austin chalk and the lower part of the Taylor marl.

## NODOSARIA ALTERNISTRIATA Morrow (Pl. 15, figs. 26, 27)

*Nodosaria alternistriata* MORROW, Journ. Pal., vol. 8, 1934, p. 190, pl. 29, figs. 1 a, b.

"Test elongate, tapering, initial end bluntly pointed; chambers few, slightly inflated, rather irregular in size; sutures slightly depressed, tending to be obscured by the surface ornamentation; wall ornamented by numerous weak, parallel, longitudinal costae which extend the full length of the test or are broken partially at the sutures; costae alternate stronger and weaker; aperture radiate, terminal. Length of holotype 0.75 mm.; diameter 0.15 mm."

The type is from the Upper Cretaceous, basal Niobrara, SE.  $\frac{1}{4}$  sec. 12, T. 12 S., R. 17 W., Ellis Co., Kansas. It has been redrawn on our plate. In some respects this closely resembles *N. fusula* Reuss, and may possibly be identical.

## NODOSARIA FUSULA Reuss (Pl. 16, fig. 1)

*Nodosaria fusula* REUSS, Palaeontographica, vol. 20, pt. 2, 1872-75 (1874), p. 82, pl. II (20), fig. 9.—FRANKE, Abhandl. Preuss. geol. Landes., vol. 111, 1928, p. 49, pl. 4, fig. 3.

The figures of this species show a form somewhat similar to *N. amphioxys* Reuss, but with a larger number of costae and the chambers slightly more cylindrical. Specimens referable to this species occur rarely at a number of localities in the lower part of the Taylor marl and in the Austin chalk. These two species were found together in Reuss' material, but the two forms as distinguished here seem to have distinct ranges.

## NODOSARIA ASPERA Reuss (Pl. 16, fig. 2)

*Nodosaria aspera* REUSS, Verstein. böhm. Kreide., pt. 1, 1845, p. 26, pl. 13, figs. 14, 15; (in GEINITZ), Grundriss der Verstein., 1845-46, p. 653, pl. 24, fig. 4.—EGGER, Abhandl. Kön. bay. Akad. Wiss., Cl. II, vol. 21, 1899, p. 80, pl. 8, fig. 15.—FRANKE, Abhandl. Preuss. geol. Landes., vol. 111, 1928, p. 50, pl. 4, fig. 14.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 35, pl. 11, fig. 5.

Test elongate, somewhat tapering with the greatest breadth near apertural end; chambers fairly distinct, subglobular, increasing rather uniformly in size as added, somewhat overlapping; sutures distinct, but only slightly depressed; wall ornamented with small, closely set spines covering the entire surface; aperture with a slender, elongate, cylindrical neck projecting



well beyond the outline of the final chamber. Length up to 1.60 mm.; diameter 0.50-0.55 mm.

The types of this species are from the Cretaceous of Bohemia, and it has been recorded several times from Central Europe. In our material, except for the record from Trinidad, it has occurred rarely at localities in the Taylor marl or its equivalents, a range in general in accord with that in the European Cretaceous.

**NODOSARIA NAUMANNI** Reuss (Pl. 16, fig. 7)

*Nodosaria naumanni* REUSS, Palaeontographica, vol. 20, pt. 2, 1872-75 (1874), p. 82, pl. II (20), fig. 11.—FRANKE, Abhandl. Greifswald Univ., Geol.-pal. Inst., vol. 6, 1925, p. 40, pl. 3, fig. 31; Abhandl. Preuss. geol. Landes., vol. 111, 1928, p. 42, pl. 3, fig. 29.

A very few specimens from the Taylor marl are assigned to this species. They are straight, tapering, composed of few chambers which are slightly inflated, somewhat overlapping and increasing in length as added. Our figured specimen closely resembles the figures given of European specimens of this species.

**NODOSARIA GRACILITATIS** Cushman (Pl. 16, figs. 3-6)

*Nodosaria gracilitatis* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 41, pl. 6, figs. 23-26.

Test very elongate, slender, of nearly equal diameter throughout, initial end with a short spine into which the basal costae fuse; chambers distinct, elongate, cylindrical or slightly fusiform, not inflated; sutures limbate, not depressed; wall translucent, ornamented with 6 to 12 longitudinal costae, slightly raised, thin, highest at the base of the proloculum where they fuse into the initial spine; aperture radiate, at the end of a conical projection of the last-formed chamber. Length up to 4.00 mm. or more; diameter 0.20 mm.

The types are from the lower Taylor marl, road cut, E. bank, near crest of hill, 14.4 miles S. of Paris, 0.9 mile N. of Lake City, Delta Co., Texas.

This is a peculiar species, rather common at this locality, but as specimens are very slender, they are easily broken. It differs from *N. filiformis* Reuss in the much more elongate chambers, non-depressed sutures, the ornamentation covering the entire test, and the very elongate proloculum.

**NODOSARIA PROBOSCIDEA** Reuss (Pl. 16, figs. 8, 9)

*Nodosaria proboscidea* REUSS, in Haidinger's Nat. Abhandl., vol. 4, 1851, p. 7, pl. 1, fig. 6.

Reuss gave this name to a form found in the Cretaceous of Lemberg. It is a short form, with a few, strongly overlapping chambers, the apertural end drawn out into a long slender neck, and the surface ornamented by longitudinal costae running the length of the test, uninterrupted at the sutures.

Such forms occur in our material from the upper part of the Taylor marl, but are rare. The stratigraphic position in both regions is very similar.

**NODOSARIA AMPHIOXYS** Reuss (Pl. 16, fig. 10)

*Nodosaria amphioxys* REUSS, Palaeontographica, vol. 20, pt. 2, 1872-75 (1874), p. 82, pl. II (20), fig. 8.—EGGER, Abhandl. Kön. bay. Akad. Wiss., Cl. II, vol. 21, 1899, p. 76, pl. 8, fig. 9.—FRANKE, Abhandl. Greifswald Univ., Geol.-pal. Inst., vol. 6, 1925, p. 42, pl. 3, fig. 39; Abhandl. Preuss. geol. Landes., vol. 111, 1928, p. 48, pl. 4, fig. 2.—STORM, Lotos, vol. 77, 1929, p. 46, pl., fig. 6.

Reuss and subsequent authors have figured under this name a slender species with acute or spinose initial end, regularly tapering with the greatest breadth at the last-formed chamber, increasing regularly but rather rapidly in size as added; sutures only slightly depressed; wall ornamented by a few longitudinal costae, running across the sutures. Our specimens are all rather small and thin-walled. They occur rarely in the upper Taylor and in the Navarro. It may be somewhat difficult to distinguish from the following species.

**NODOSARIA OBSCURA** Reuss (Pl. 16, figs. 11, 12)

*Nodosaria obscura* REUSS, Verstein. böhm. Kreide., pt. 1, 1845, p. 26, pl. 13, figs. 7-9; (in GEINITZ), Grundriss der Verstein., 1845-46, p. 653, pl. XXIV, fig. 3; Palaeontographica, vol. 20, pt. 2, 1872-75 (1874), p. 81, pl. II (20), figs. 1-4.—HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1910, p. 418, pl. 7, fig. 7.—FRANKE, Abhandl. Greifswald Univ., Geol.-pal. Inst., vol. 6, 1925, p. 43, pl. 3, fig. 40.—STORM, Lotos, vol. 77, 1929, p. 47, pl., figs. 1-5.—CUSHMAN, Tenn. Div. Geol., Bull. 41, 1931, p. 32, pl. 4, figs. 3, 4.—BROTZEN, Sver. geol. under., ser. C, No. 396, 1936, p. 84, pl. 5, figs. 24, 25; text figs. 26, 27.

Test somewhat fusiform, of variable length, broadest toward the apertural end, the initial end usually pointed, sometimes with a definite spine; chambers often obscured by the ornamentation of the test, not inflated; sutures often indistinct, not depressed; wall ornamented by distinct, longitudinal costae, 10-15, continuous over the whole test, coalescing at the apertural end, which



often has a distinct, collar-like thickening about the aperture, which is terminal and obscurely radiate. Length up to 1.00 mm.; diameter 0.25-0.30 mm.

This species was originally described from the Cretaceous of Bohemia. Specimens selected by Reuss have been studied. The species occurs in America in the Upper Cretaceous, particularly in the upper part of the Taylor marl and its equivalents, as well as in the lower Navarro.

**NODOSARIA NAVARROANA** Cushman (Pl. 16, figs. 16, 17)

*Nodosaria navarroana* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 13, 1937, p. 103, pl. 15, fig. 11.

Test small, elongate, of about equal diameter throughout except at the rapidly tapering initial end; chambers distinct, rapidly increasing in size and height in the early stages, especially in the microspheric form, very slightly inflated in the adult, not inflated in the earlier stages; sutures distinct, slightly limbate; wall ornamented by four longitudinal costae, running uninterrupted from the initial end to the aperture which is terminal and radiate. Length 0.50-0.60 mm.; diameter 0.08-0.10 mm.

The types are from the Navarro group, Corsicana marl, pit of Corsicana Brick Co., 2 miles S. of the Court House at Corsicana, Texas. This species differs from *Nodosaria affinis* Reuss in the very much smaller size and the number of costae, typically four instead of many. The species seems to be characteristic of this horizon.

**NODOSARIA CORSICANANA** Cushman (Pl. 16, figs. 13-15)

*Nodosaria corsicanana* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 42, pl. 7, figs. 1-4.

Test elongate, slightly if at all tapering, initial end pointed with a distinct spine; chambers few, usually 2 to 5, slightly inflated, increasing but little in length or size as added, fusiform, only slightly overlapping; sutures distinct, slightly depressed, limbate; wall ornamented by a few, 10 to 14, longitudinal costae, only slightly raised and narrow, slightly twisted, not interrupted at the sutures; aperture radiate, terminal. Length up to 3.00 mm.; diameter 0.25-0.35 mm.

The types are from the Corsicana marl, road ditch, 3.5 miles NW. of Union Seminary School, 4.3 miles SSE. of Corbet, Navarro Co., Texas. This is a characteristic species of the Corsicana

marl. It somewhat resembles *N. sceptriformis* Olszewski, but the chambers are more elongate, and the costae more delicate, and are twisted.

**NODOSARIA VELASCOENSIS** Cushman (Pl. 16, figs. 20-22)

*Nodosaria fontannesii* BERTHELIN, var. *velascoensis* CUSHMAN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 504, pl. 10, fig. 12.

*Nodosaria velascoensis* CUSHMAN and JARVIS, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 97, pl. 13, figs. 15, 16; Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 35, pl. 11, figs. 1-4.—CUSHMAN and CAMPBELL, Contr. Cushman Lab. Foram. Res., vol. 11, 1935, p. 72, pl. 11, fig. 3.

Test elongate, subcylindrical, very slightly tapering, greatest width developed by the last-formed chamber, consisting of numerous chambers increasing in height as added, the last ones somewhat longer than broad, circular in transverse section; sutures only slightly depressed, ornamentation consisting of very fine longitudinal costae which in the early portion may be continuous, but over most of the test are restricted to the areas over the sutures. Length up to 2.50 mm.; breadth 0.30-0.40 mm.

This form was originally described from the Velasco shale of Mexico, where it is fairly common. It is also common in the Upper Cretaceous, pit at Lizard Springs, near Guayaguayare, southeastern Trinidad, and shows a considerable degree of variation, especially in the ornamentation of the test. The costae are usually somewhat spirally arranged, especially in the early portion, and in later chambers are often restricted to the area immediately adjoining the sutures.

**NODOSARIA LIMONENSIS** Cushman (Pl. 16, figs. 18, 19)

*Nodosaria limonensis* CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 1, pt. 1, 1925, p. 21, pl. 3, figs. 4 *a*, *b*; Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 596, pl. 18, figs. 7 (?), 13.

Test elongate, subconical, widest near the base, circular in transverse section; chambers indistinct from the surface; sutures indistinct; wall ornamented by a series of eight broad, prominent, longitudinal costae which, toward the base, become bifurcate; between these, above the early portion, are very thin, delicate, longitudinal costae alternating with the thick ones; aperture somewhat projecting, radiate. Length of type specimen, which is evidently incomplete, 0.85 mm.; breadth at base 0.25 mm.

The types are from the Velasco shale, Tamalte Arroyo,



Hacienda el Limon, State of San Luis Potosi, Mexico. No complete specimens have been found, but fragmentary ones occur at various localities in the Velasco shale of Mexico. Two specimens from the Taylor marl, 3.2 miles SW. of Mart, McLennon Co., Texas, seem identical with the types.

**NODOSARIA LIMBATA** d'Orbigny (Pl. 16, figs. 23, 24)

*Nodosaria limbata* D'ORBIGNY, Mém. Soc. géol. France, vol. 4, 1840, p. 12, pl. 1, fig. 1.—BROWN, Ann. Mag. Nat. Hist., ser. 2, vol. 12, 1853, p. 240, pl. 9, fig. 1.—CUSHMAN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 595, pl. 18, fig. 14.—FRANKE, Abhandl. Preuss. geol. Landes., vol. 111, 1928, p. 42, pl. 3, figs. 27, 28.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 32, pl. 10, fig. 5.—MACFADYEN, *Discovery* Rept., vol. 7, 1933, p. 7, text fig. E.

*Nodosaria concinna* CUSHMAN and JARVIS (not REUSS), Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 97, pl. 14, figs. 5, 11; Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 31, pl. 10, fig. 4.

Test cylindrical or very slightly tapering, initial end with or without a spine; chambers distinct, few, inflated, only slightly overlapping, somewhat pyriform, the apertural end drawn out to a point; sutures distinctly limbate, depressed; wall smooth; aperture radiate, terminal. Length 1.00 mm. or more; diameter 0.35-0.45 mm.

This species was described by d'Orbigny from the Upper Cretaceous White Chalk, of the Paris Basin at Meudon. I collected at Meudon, but failed to find the species which d'Orbigny records as very rare. Material from the Upper Cretaceous of Trinidad and Mexico contains specimens which seem to belong to d'Orbigny's species. They show some variation as to size, but in other respects are fairly constant in their characters. It was not found in the Texas region. The forms I have referred to *N. concinna* Reuss, after a study of European material, seem best placed in *N. limbata*.

**NODOSARIA LIMBATA** d'Orbigny, var. **BASIORNATA** Cushman and Jarvis  
(Pl. 16, figs. 25, 26)

*Nodosaria limbata* D'ORBIGNY, var. *basiornata* CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 32, pl. 10, figs. 7, 8.

Variety differing from the typical in the ornamentation of the surface, which consists of numerous subnodose projections on the smaller part of each chamber.

The only records for this ornate variety are from the Upper

Cretaceous, pit at Lizard Springs, near Guayaguayare, south-eastern Trinidad.

**NODOSARIA LIMBATA** d'Orbigny, var. **TUMIDATA** Cushman and Jarvis (Pl. 16, fig. 27)

*Nodosaria limbata* D'ORBIGNY, var. *tumidata* CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 32, pl. 10, figs. 6 *a*, *b*.

Variety differing from the typical in the shape of the chambers, which are somewhat conical, the greatest breadth being nearly at the base of the basal portion, which is very strongly truncated.

The types are from the Upper Cretaceous, pit at Lizard Springs, near Guayaguayare, southeastern Trinidad. Similar forms also occur in the Velasco shale of Mexico.

**NODOSARIA BREVITESTA** Franke (Pl. 16, fig. 28)

*Nodosaria brevitesta* FRANKE, Abhandl. Griefswald Univ., Geol.-pal. Inst., vol. 6, 1925, p. 42, pl. 3, fig. 37.—CUSHMAN and JARVIS, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 97, pl. 13, fig. 10; Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 35, pl. 10, fig. 11.

Specimens from the Upper Cretaceous, pit at Lizard Springs, near Guayaguayare, southeastern Trinidad, have been referred to this species. They also somewhat resemble *N. clausa* Marsson. Specimens are rare, and the specimen figured is probably not an adult.

**NODOSARIA cf. MARCKI** Reuss (Pl. 16, fig. 29)

*Nodosaria cf. marcki* CUSHMAN and JARVIS, Contr. Cushman Lab. Foram. Res., vol. 4, 1928, p. 97, pl. 14, fig. 4; Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 34, pl. 10, fig. 12.

## EXPLANATION OF PLATE 15

*a*, front view; *b*, apertural view.

FIGS. 1-6. *Dentalina delicatula* Cushman. Corsicana marl, Travis Co., Tex. 1,  $\times 60$ . Holotype. 2-6,  $\times 38$ . Paratypes. 7. *D. sp*(?).  $\times 60$ . (After Cushman and Jarvis.) Cretaceous, Trinidad. 8-23. *Nodosaria affinis* Reuss. 8-11, 13, Ripley formation, Henderson Co., Tenn. 8-11,  $\times 38$ . 13,  $\times 30$ . 8, Extreme megalospheric form. 13, Extreme microspheric form. 12, 14-16, 23,  $\times 25$ . Corsicana marl, Limestone Co., Tex. 17, 20, 22,  $\times 25$ . Saratoga chalk, Howard Co., Ark. 20, Extreme megalospheric form. 18,  $\times 20$ . (After Cushman and Jarvis.) Cretaceous, Trinidad. 19,  $\times 38$ . Upper Taylor marl, Kaufman Co., Tex. 21,  $\times 38$ . White chalk, Antigua, B. W. I. 24, 25. *N. distans* Reuss.  $\times 38$ . Gober tongue, Austin, Fannin Co., Tex. 26, 27. *N. alternistriata* Morrow. 26,  $\times 75$ . Holotype redrawn. Ellis Co., Kans. 27,  $\times 60$ . Selma chalk (lower part), Lee Co., Miss.









In the above references, material from the Upper Cretaceous, pit at Lizard Springs, southeastern Trinidad, has been referred to Reuss' species. It is very similar to material so identified and figured by Franke (Abhandl. Greifswald Univ., Geol.-pal. Inst., vol. 6, 1925, pl. 3, fig. 22 a). Similar specimens occur in the Velasco shale of Mexico.

**NODOSARIA ORTHOPLEURA** Reuss (Pl. 16, fig. 30)

*Nodosaria orthopleura* REUSS, Sitz. Akad. Wiss. Wien, vol. 46, pt. 1, 1862 (1863), p. 89, pl. 12, figs. 5 a, b.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 33, pl. 10, fig. 10.

Test very elongate, slightly tapering at each end, for most of its length with the sides parallel or nearly so; chambers numerous, not inflated; sutures fairly distinct, slightly limbate; wall ornamented by a few distinct, elevated costae running from the base to the apertural end; aperture terminal, radiate.

The figured specimen is from the Upper Cretaceous, pit at Lizard Springs, near Guayaguayare, southeastern Trinidad. This is a fragmentary specimen, but when entire it probably measured

EXPLANATION OF PLATE 16

a, front view; b, apertural view.

FIG. 1. *Nodosaria fusula* Reuss.  $\times 150$ . Lower Taylor marl, Collin Co., Tex. 2. *N. aspera* Reuss.  $\times 30$ . (After Cushman and Jarvis.) Cretaceous, Trinidad. 3-6. *N. gracilitatis* Cushman.  $\times 38$ . Lower Taylor marl, Delta Co., Tex. 3, Holotype. 4-6, Paratypes. 7. *N. naumanni* Reuss.  $\times 68$ . Lower Taylor marl, Ellis Co., Tex. 8, 9. *N. proboscidea* Reuss.  $\times 68$ . 8, Upper Taylor marl, Bexar Co., Tex. 9, Selma chalk (middle part), Prentiss Co., Miss. 10. *N. amphioxys* Reuss.  $\times 110$ . Selma chalk (middle part), Prentiss Co., Miss. 11, 12. *N. obscura* Reuss. Ripley formation, Henderson Co., Tenn. 11,  $\times 68$ . 12,  $\times 38$ . 13-15. *N. corsicana* Cushman.  $\times 23$ . Corsicana marl. 13, 14, Limestone Co., Tex. 15, Navarro Co., Tex. 16, 17. *N. navarroana* Cushman. Corsicana marl, Navarro Co., Tex. 16,  $\times 110$ . 17,  $\times 55$ . 18, 19. *N. limonensis* Cushman.  $\times 27$ . Pecan Gap chalk, McLennan Co., Tex. 20-22. *N. velascoensis* Cushman. (After Cushman and Jarvis.) Cretaceous, Trinidad. 20, 21,  $\times 15$ . 22,  $\times 30$ . 23, 24. *N. limbata* d'Orbigny. (After Cushman and Jarvis.) Cretaceous, Trinidad. 23,  $\times 60$ . 24,  $\times 42$ . 25, 26. *N. limbata* d'Orbigny, var. *basinornata* Cushman and Jarvis.  $\times 20$ . (After Cushman and Jarvis.) Cretaceous, Trinidad. 27. *N. limbata* d'Orbigny, var. *tumidata* Cushman and Jarvis.  $\times 20$ . (After Cushman and Jarvis.) Cretaceous, Trinidad. 28. *N. brevitesta* Franke.  $\times 60$ . (After Cushman and Jarvis.) Cretaceous, Trinidad. 29. *N. cf. marcki* Reuss.  $\times 60$ . (After Cushman and Jarvis.) Cretaceous, Trinidad. 30. *N. orthopleura* Reuss.  $\times 20$ . (After Cushman and Jarvis.) Cretaceous, Trinidad. 31. *N. monile* Hagenow.  $\times 20$ . (After Cushman and Jarvis.) Cretaceous, Trinidad. 32-34. *N. paupercula* Reuss.  $\times 20$ . (After Cushman and Jarvis.) Cretaceous, Trinidad.

8 to 10 millimeters in length. Somewhat similar specimens, more definitely quadrangular in section than the Trinidad ones, occur in the Velasco shale of Mexico.

**NODOSARIA MONILE** Hagenow (Pl. 16, fig. 31)

*Nodosaria monile* HAGENOW, Neues Jahrb., 1842, p. 568.—REUSS, Verstein. böhm. Kreide., pt. 1, 1845, p. 27, pl. 8, fig. 7.—FRANKE, Abhandl. Preuss. geol. Landes., vol. 111, 1928, p. 31, pl. 2, figs. 27 a, b. —CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 33, pl. 10, fig. 9.—CUSHMAN and CAMPBELL, Contr. Cushman Lab. Foram. Res., vol. 11, 1935, p. 71, pl. 10, fig. 5.

Test elongate, very slightly tapering; chambers very distinct, inflated, subglobular throughout; sutures distinct, depressed especially toward the later-formed portion; wall smooth; aperture terminal, radiate, not projecting. Length 1.50 mm.; diameter 0.25 mm.

This species is very close to that recorded as *Nodosaria nuda* (Cushman and Church, Proc. Calif. Acad. Sci., ser. 4, vol. 18, 1929, p. 510, pl. 39, figs. 4-6). That species, however, has the chambers becoming elongate in the adult, while in *N. monile* the chambers are subglobular throughout, and show little tendency to lengthen. Specimens from the Upper Cretaceous, pit at Lizard Springs, near Guayaguayare, southeastern Trinidad, are very close indeed to those figured by Franke from Germany in the above reference. Specimens identical with these occur in the Velasco shale of Mexico.

**NODOSARIA PAUPERCULA** Reuss (Pl. 16, figs. 32-34)

*Nodosaria paupercula* REUSS, Verstein. böhm. Kreide., pt. 1, 1845, p. 26, pl. 12, fig. 12.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1932, p. 33, pl. 10, figs. 14, 15.

The specimens figured are from the Upper Cretaceous, pit at Lizard Springs, near Guayaguayare, southeastern Trinidad. They rather closely resemble the figures given by Reuss, but may not be identical. Not enough material is available to give the full characters of the species.

## RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on foraminifera that have come to hand.

Le Calvez, Jean. Répartition des Grandes Foraminifères de la Rade de

- Villefranche-sur-Mer.—Soixante et onzième Congrès des Sociétés savantes, 1938, pp. 265-268.
- Foraminifères de Côtes d'Indo Chine Récoltés par C. Dawydoff.—Archiv. Zool. Exper. Gen., vol. 80, Notes et Revue, No. 3, 1939, pp. 93-95.
- Acosta, José T. *Quinqueloculina torrei*, un Nuevo Foraminifero de la Costa de Cuba.—Torreia, No. 1, July 18, 1939, 3 pp., 1 pl.
- LeRoy, L. W. Some Small Foraminifera, Ostracoda and Otoliths from the Neogene ("Miocene") of the Rokan-Tapanoei Area, Central Sumatra.—Nat. Tij. Ned.-Indie, Deel. XCIX, 1939, pp. 215-296, pls. 1-14, map and chart.—The following new species and varieties are described and figured: *Haplophragmoides compressa*, *Ammomarginulina arenacea*, *Cyclammina minima*, *Spiroplectammina arenacea*, *S. arenasuturata*, *Textularia malaccaensis*, *Quinqueloculina newcombi*, *Robulus sumatrensis*, *R. tangens*, *Dentalina doemaiensis*, *Nodosaria aliantanensis*, *Planularia patens* (Brady), var. *aspinosa*, *Elphidium koeboense*, *Plectofrondicularia longistriata*, *Bolivinita quadrilatera* (Schwager), var. *sumatrensis*, *Bolivina longicostata*, *B. gesteri*, *B. marginoserrata*, *B. sumatrensis*, *B. uniforminata*, *Loxostomum irregulare*, *Bifarina crenulata*, *Uvigerina multicostata*, *U. soendaensis*, *Siphogenerina pangoenensis*, *Siphonodosaria excentrica*, *Rotalia beccarii* (Linnaeus), var. *koeboensis*, var. *gigantica*, var. *baganensis*, *R. indica*, *Baggina compressa*, *B. inflata*, *Globigerina siakensis*, *G. baroemoenensis*, *Globigerinoides sacculiferus* (Brady), var. *immatura*, *Globorotalia barisanensis*, *Planulina evoluta*, *Cibicides foxi*, *C. dorsopustulosus*, *C. koeboeensis*, *C. rokanensis*, *C. tapoengensis*, *C. tapanoeiensis*, *C. telisaensis*.
- Macfadyen, W. A. *Elphidium icenovum*, a new Species of Foraminifera from the sub-Recent Deposits of the Cambridgeshire Fenland.—Ann. Mag. Nat. Hist., ser. 11, vol. iv, Dec., 1939, pp. 610-613, pl. XV.
- Hanzawa, Shoshiro. Revision of "*Nummulites cumingii* (Carpenter)."—Jap. Journ. Geol. Geogr., vol. XVI, 1939, pp. 225-232, pls. XV, XVI.
- Laiming, Boris. Some Foraminiferal Correlations in the Eocene of the San Joaquin Valley, California.—Proc. Sixth Pacific Science Congress, vol II, 1939, pp. 535-568, text figs. 1-9.
- Israelsky, M. C. Notes on Some Foraminifera from Marysville Buttes, California.—L. c., pp. 569-595, pls. 1-7.—Numerous species noted and figured; none new.
- Adams, Bradford C. Foraminifera in Zonal Paleontology.—L. c., pp. 665-670, 2 charts.
- Bermudez, Pedro J. and José T. Acosta. Resultados de la Primera Expedition en las Antillas del Ketch Atlantis Bajo los Auspicios de las Universidades de Harvard y Habana. Nuevas Especies de Foraminíferos Recientes.—Mem. Soc. Cub. Hist. Nat., vol. 14, No. 1, 1940, pp. 55-58, pl. 9.—*Gaudryina quadrangularis* Bagg, var. *antillana*, n. var.; *Cystammina aguayoi*, n. sp.; *Chrysalogonium brodermanni*, n. sp.; *Cassidulina palmerae*, n. sp.
- Van der Weijden, W. J. M. Het Genus *Discocyclina* in Europa. Een Monografie naar Aanleiding van een Heronderzoek van het Tertiär-profiel van Biarritz.—Leiden, 1940, 116 pp., 12 pls.—New subgenera: *Discocyclina*, *Eudiscodina*, *Umbilicodiscodina*, *Isodiscodina*, *Tryblidiscodina*, and a new species *D. angustae*.



- Brodermann, Jorge. Determinacion Geologica de la Cuenca de Vento.—Tercer Congreso Nacional de Ingenieria, Havana, 1940, pp. 1-57, text fig. and map.—Lists numerous foraminifera.
- Hanzawa, Shoshiro. Micropalaeontological Studies of Drill Cores from a Deep Well in Kita-Daito-zima (North Borodino Island).—Jubilee Publ. Com. Prof. H. Yabe's 60th Birthday, 1940, pp. 755-802, pls. 39-42.—*Miogypsinella* n. gen., *M. borodinensis* n. sp., *Miogypsinoides dehaarti* (Van der Vlerk), var. *pustulosa* n. var., *M. lateralis* n. sp., *Lepidocyclina* (*Nephrolepidina*) *plicomargo* n. sp., *Borodinia* n. gen., *B. septertrionalis* n. sp.
- Lalicker, C. G. and Irene McCulloch. Some Textulariidae of the Pacific Ocean.—Allan Hancock Pacific Exped., vol. 6, No. 2, 1940, pp. 115-143, pls. 13-16.—Of 27 species and varieties described and figured, the following are new: *Textularia astutia*, *T. aura*, *T. lancea*, *T. lauta*, *T. orbica*, *T. plaga*, *T. ramosa*, *T. secasensis*, *T. scrupula*, *T. vola*.
- Smith, J. Fred, Jr. Stratigraphy and Structure of the Devil Ridge Area, Texas.—Bull. Geol. Soc. Amer., vol. 51, 1940, pp. 597-638, 6 pls., 7 text figs.—Mentions several foraminifera.
- Acosta, José T. Nuevos Foraminíferos de la Costa Sur de Cuba.—Torreia, No. 3, May 3, 1940, pp. 25, 26, pl. IV.—*Triloculina fitterrei*, n. sp., and var. *meningoï*, n. var.
- Palmer, Dorothy K. Foraminifera of the Upper Oligocene Cojimar Formation of Cuba.—Pt. 1, Mem. Soc. Cub. Hist. Nat., vol. 14, No. 1, March 30, 1940, pp. 19-35; Pt. 2, l. c., No. 2, June 29, 1940, pp. 113-132, pls. 17, 18.—*Textularia calva* Lalicker, var. *cojimarensis*, n. var.; *T. yumuriana*, n. sp.; *Listerella cojimarensis*, n. sp.; *Lenticulina subaculeata* (Cushman), var. *yumuriana*, n. var.; *Planularia cushmani*, n. sp.; var. *ornata*, n. var.
- Coryell, H. N. and Frances Charlton Rivero. A Miocene Microfauna of Haiti.—Journ. Pal., vol. 14, No. 4, July, 1940, pp. 324-344, pls. 41-44.—A fauna of 53 genera and 111 species. There are 20 species and 1 variety described as new, as follows: *Textularia warrenites*, *Fissurina crenulata*, *Fronidularia bulbosa*, *Lagenonodosaria extensa*, *L. sigmoidea*, *Lingulina tricenata*, *Marginulina papillata*, *M. howeana*, *Nodosaria helicata*, *N. sublineata*, *Pseudoglandulina trochoformis*, *Robulus oblongus*, *Vaginulina obliquata*, *Laticarinina angustata*, *Cibicides sinistralis*, *C. robertsonianus*, var. *haitiensis*, *C. perforatus*, *Valvulineria collis*, *Globigerina haitiensis*, *Uvigerina laviculata*, *U. quadrata*.
- Mellen, Frederic F. Genus *Lituola* in the Adams Oil deep test, Lafayette County, Mississippi.—L. c., pp. 378, 379.—Records *L. erecta* Mellen and Gault, and *L. taylorensis* Cushman and Waters.
- Tromp, S. W. The Value of Quantitative Data in Microstratigraphy.—L. c., pp. 379-381.—Describes a method of using foraminifera in microstratigraphic work.
- Gravell, Donald W. and Marcus A. Hanna. New Larger Foraminifera from the Claiborne of Mississippi.—L. c., No. 5, Sept., 1940, pp. 412-416, pl. 57.—Three new species described: *Camerina barkeri*, *C. mississippiensis*, and *Lepidocyclina* (*Lepidocyclina*) *claibornensis*.

## FORAMINIFERA

Special Publ. No. 7. A Monograph of the Foraminiferal Family Verneulinidae. 170 pages and 20 plates....\$3.50

Special Publ. No. 8. A Monograph of the Foraminiferal Family Valvulinidae. 210 pages and 24 plates.....\$4.00

Special Publ. No. 9. A Monograph of the Subfamily Virgulininae. 240 pages and 24 plates.....\$4.00

Price list of available foraminiferal literature sent on request.

Topotypes of many species available: 50c per slide.

### CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

SHARON, MASS., U. S. A.

## FORAMINIFERA

### Their Classification and Economic Use

THIRD EDITION, REVISED AND ENLARGED WITH  
AN ILLUSTRATED KEY TO THE GENERA

by JOSEPH A. CUSHMAN

viii + 480 pages, 78 plates, 8 text figs.

PRICE: \$6.00\*

ORDER FROM:

*Harvard University Press, Cambridge, Mass., U. S. A.*

\*Postage paid on orders accompanied by remittance.



